

or unwholesome qualities accompanied by the most conspicuous orange and black aposematic coloration may afford no protection. Furthermore, it is of great interest to observe that the same species of bird was the only one in which two conspicuous and almost certainly distasteful Saturniid moths were found. The *Carabidae* of the genera *Anthia*, *Polyhirma*, *Piezia*, and *Scarites* are not so remarkable. *Scarites* is probably nocturnal and entirely procryptic, while the defensive secretions of the three other genera may be discharged and lost as the result of the attacks of an experienced enemy.

Outside the Coleoptera, the number of birds which ate Pentatomid bugs is remarkable (five species), and it would be interesting if it were possible to obtain the remains and make out the species of these Hemiptera. The specialization of enemies to feed upon forms which have become excessively abundant through specialization in their modes of defence is seen in the two species which contained ants, and the three which had eaten scorpions. The hairy caterpillars eaten by cuckoos are a similar case; this group of birds being specialized to feed on insects which are specially defended against the majority of insect-eaters. The fact that *Phymateus morbillosus*, a large, conspicuous, and strong-smelling locust, had been eaten, is also of interest. *Solpuga marshalli*, in spite of its formidable appearance, is quite harmless, with procryptic appearance and habits. The Tables as a whole afford wonderfully strong support to the existing theories which explain cryptic colouring and instinct as the defence of forms which are eagerly sought for as food by numerous enemies, and an aposematic appearance and mode of life as the defence of specially-protected forms only attacked under the stress of hunger or by comparatively few specially-adapted foes.—E. B. P.]

12. RECORDS OF ATTACKS ON LEPIDOPTERA, ESPECIALLY BUTTERFLIES, BY WILD SOUTH AFRICAN BIRDS. (G. A. K. M.)

[The stimulus which induced Mr. Marshall to collect observations on the attacks of birds upon butterflies was provided chiefly by the account of the discussion which followed Dr. F. A. Dixey's paper on "Mimetic Attraction" (Trans. Ent. Soc. London, 1897, p. 317; Discussion in TRANS. ENT. SOC. LOND. 1902.—PART III. (NOV.) 24

Proc. 1897, pp. xx-xxxii, xxxiv-xlvii). The following extracts from a letter indicate the line Mr. Marshall would have taken had he been in England at the time.—E. B. P.]

Malvern, Natal; Oct. 7, 1897.—I am much struck with the large amount of adverse criticism levelled against the theory of even Batesian mimicry. The theory of convergence (Müllerian mimicry) might perhaps be considered as debatable, but how any one who has paid any attention to the subject can doubt the reality of Batesian mimicry, I cannot understand, and the attempt to explain it away by climatic causes seems to me weak in the extreme. If the view, advocated by many, that birds cannot be reckoned among the principal enemies of butterflies in their imago state, be true, then I consider that we may practically abandon the whole theory of mimicry as at present applied to the *Acræinæ* and *Danaïinæ* of South Africa at all events, for from what I have observed of these insects I am convinced that their warning coloration cannot have reference to either mantises, *Asilidæ*, or lizards, which are practically the only other enemies that can be taken into account. Moreover, the swift flight of the majority of edible species can only have been developed to enable them to escape from *winged* enemies, and that this development is due to *Asilidæ* or dragon-flies is more than I can believe. Certainly the paucity of records of birds eating butterflies is somewhat disconcerting, but this is doubtless due to the fact that not sufficient attention has been paid to the subject, which would entail long and patient observation of the birds themselves, an occupation that the average entomologist is not likely to indulge in when out collecting. Personally I do not suppose I have seen such an occurrence more than perhaps half-a-dozen times; the birds being the Paradise flycatcher (*Terpsiphone perspicillata*), the bee-eater (*Merops apiaster*), and two rollers (*Coracias spatulata* and *Eurystomus afer*); but then I admit that I have paid little or no attention to the matter until quite recently.

The habits of the *Teracoli*, especially in their winter forms, have always seemed to me strongly suggestive of their being frequently attacked by birds. With hardly an exception they are fairly swift fliers (especially the "purple-tips"), keeping comparatively close to the ground and dodging well. If struck at gently as they fly by, they dodge and hurry onwards but still continue their

flight; if however they be thoroughly frightened by continued strokes of the net, they will dart rapidly on for a short distance, then vanish—or, in other words, they settle with extreme suddenness, and their under-side colouring harmonizes so well with the sandy soil they love that they are very difficult to detect. It seems to me that such a habit can only have been developed for the purpose of escaping from birds, and must be very effectual in most cases. I have noticed that the summer forms, which have not the sandy-coloured under-side do not adopt these tactics, but rely on their flight alone—probably because food is more plentiful for insectivorous birds at that season.

[After this, Mr. Marshall kept a careful record of observations. His results, including one observation made at an earlier date, are shown on pp. 357–9 in the form of a diary. The two following letters bear on the same subject.—E. B. P.]

Salisbury, March 6, 1898.—I was much interested in your arguments * for Common Warning Colours in butterflies and your remarks on their probable enemies, but I must candidly confess that I am not altogether convinced. The difference in our views lies in your fundamental proposition that butterflies are an easy prey for birds to capture from a general point of view. If this proposition be correct, then I quite agree that your theory offers the most natural and probable explanation of the predominance of bright colours among butterflies. But from what I have seen of the South African species I could not truthfully say that I consider that they would be likely to fall an easy prey to birds, indeed I should say that the average insectivorous bird would not have a chance against most of the swift-flying species when on the wing, and would only be able to catch them under exceptionally favourable circumstances when the insects were off their guard. If this supposition be correct it would go a good way to explain how so many butterflies have been able to acquire such brilliant colours, and particularly in the case of those species which have protectively-coloured under-sides, which is the rule rather than the exception. Birds would soon learn the futility of attempting to *pursue* such species, and would only capture them by stealth, and in a more or less

* Some of the arguments here referred to are set forth on pages 500 to 502 of the present memoir.—E. B. P.

unobtrusive manner, which might account for the paucity of records. The fact that birds have been seen to capture moths more frequently than butterflies need not necessarily imply a preference for the former insects, but might be explained on the supposition that they are aware that they can be captured more or less easily on the wing, and therefore that when a moth does happen to get well up into the air in open country it is promptly pursued, whereas under similar conditions a butterfly would be allowed to pass unmolested. While on the subject of swift flight I might mention that I was much struck during my visit home with the *slow* flight of English butterflies as compared with the generality of South African species. I am inclined to agree with Trimen in his Presidential Address to the Entomological Society, that birds are among the chief enemies of butterflies. That they have been the chief, if not the only, agents in the production of mimicry, whether Batesian or Müllerian, I have little doubt. It is highly significant that mimicry in its fullest development is only to be found in forest-clad regions where insectivorous birds are most abundant. Moreover, I am not aware of a single instance of true mimicry among species which *habitually* settle on the ground.

Salisbury, March 10, 1898.—It would seem that mere unpleasantness of taste or smell would hardly be sufficient to give so great an immunity from attack from birds as is apparently enjoyed by the *Danainæ* and *Acræinæ*, unless accompanied by poisonous or unwholesome qualities—at least, if we may judge by other orders of insects. A large number of Rhynchota, for instance, possess a very unpleasant smell, and yet their colouring is procryptic instead of aposematic. In the crop of the great spotted cuckoo I have found a large green Pentatomid, which in the strength and unpleasantness of its smell is only beaten by *Petaseelis remipes*, our largest Hemipteron. Again, in the crop of the racquet-tailed roller (*Coracias caudata*, Trim.) I have found a full-grown specimen of a large *Phymateus* locust, which is a most evil-smelling beast. This insect appears to combine procryptic and aposematic colours; for when settled its general green colour is eminently protective, but during its laboured flight it is most conspicuous owing to its brilliant crimson and purple hind-wings. If annoyed when settled on the ground they often raise their wings over their backs (clearly to exhibit

the bright colours), exuding at the same time an odoriferous frothy liquid from the thorax.

1897.

- March 28. While out collecting at Malvern, Durban, Natal, I saw a Paradise flycatcher (*Terpsiphone perspicillata*) catch a specimen of *Eronia cleodora*. The butterfly was hovering over a flower when the bird swooped down, seized it *with its feet*, and carried it off.

1898.

- Feb. 27. Saw a Marico wood-shrike (*Bradyornis maricensis*) dart down from a tree and catch a *Sarangesa eliminata* (Holl.), which was sitting with outspread wings on a small plant.
- March 6. Saw a flycatcher (*Pachyprora molitor*) make several futile attempts to catch a *Tarueus plinius* which was circling round the bush on which it sat.
- Nov. 23. Saw a bush kingfisher (*Haleyon chelicutensis*) catch and eat two butterflies, viz. *Junonia cebrene* and *Catopsilia florella*, both of which were captured when feeding.
- Dec. 1. C. F. M. Swynnerton saw a drongo (*Buchanga assimilis*) fly past him with a white butterfly in its beak, probably *C. florella*.
- „ 15. Remains of *Papilio demodocus* found in the stomach of a cuckoo (*Coccytes caffer*).

1899.

- Jan. 1. While watching an *Atella phalantha* hovering over a bush of its food-plant, a Paradise flycatcher (*Terpsiphone perspicillata*) darted past, and with a loud snap of its beak tried to catch the butterfly in its swoop. The latter escaped, however, and on following it up I found that the tip of one hind-wing had been cut clean off; unfortunately I had no net and failed to capture the insect.

Swynnerton shot a hobby (*Falco subbutco*), which had in its stomach an almost

complete *Terias*. The thorax and abdomen were quite uninjured, but the tips of the fore-wings were gone.

- April 26. I was watching a drongo hawking insects from the top of a dead tree; there were many *Pierinae* about, chiefly *Teracolus* and *Belenois*, but the bird paid not the least attention to them. At last a *Belenois* came by which had its wings very much shattered, so that its flight was weak and erratic; the drongo observed it at once, and swooped down on it, but I saw the butterfly drop into the long grass. Whether it was injured by the bird I could not say, as I was unable to find it, and I did not see it rise again. This episode would point to the conclusion that the fact that birds refrain from pursuing butterflies may be due rather to the difficulty in catching them, than to any widespread distastefulness on the part of these insects.

1900.

C. F. M. Swynnerton wrote from Gazaland: "In March [1900] I saw a *Pratincola torquata* [South African stonechat] in chase of *Tarucus plinius*. Had it not been frightened off by coming face to face with me, it would undoubtedly have caught it. I think I told you long ago of having found the wings of a lot of butterflies, chiefly *P. corinnus*, below the branch of a tree on which some swallows were constantly settling."

- May 13. Salisbury. Saw a drongo (*Buchunga assimilis*) swoop from a tree and catch, what I took to be an injured *Belenois*, which it dropped almost at once. I marked the insect down, and found it to be a common white moth of the distasteful genus *Diacrisia* (*D. maculosa*).

1901.

- Dec. 17. Melsetter, 5500 feet, Gazaland. A specimen of the large, conspicuous, Hypsid

moth *Callioratis bellatrix* was seized and rejected by a drongo, undoubtedly a young bird, judging by its plumage. [The moth, which is now in the Hope Department, has lost most of the head, but is otherwise uninjured.—E. B. P.]

13. RECORDS OF ATTACKS ON BUTTERFLIES BY WILD BIRDS IN INDIA AND CEYLON, BY COLONEL J. W. YERBURY, R.A.

[Colonel Yerbury has kindly extracted from his notes all the observations he has made bearing on this interesting question.—E. B. P.]

“About the year 1884 a discussion arose in the Bombay papers as to whether birds preyed on butterflies, and the general opinion expressed was that it was comparatively rare for them to do so. In common with some other members of the Bombay Natural History Society, I determined to watch and note the results. My records taken from old diaries are as follows:—

1884.

Neighbourhood of Poona and Aden. None.

1885.

Sept. 23. Aden, Campbellpore, and Murree Hills. Road up Thundiani, near the Kala Pani Bungalow. Saw a young king-crow, *Dicrurus ater*, stoop at a big blue *Papilio*, either *P. polycctor* or *P. arcturus*, and miss it. The bird did not repeat the attempt.

1886.

Sept. 2. Campbellpore, Thundiani, etc. Road up Thundiani, near top of the hill. Saw a young king-crow stoop at a specimen of *Vanessa kaschmirensis*, and after missing it once take it at the second attempt. Did not notice whether the insect was eaten.